WHAT IS CLAIMED IS

1. A projection apparatus for projecting a pattern formed on a mask held by a mask stage onto a substrate on a substrate stage and transferring the projected pattern, comprising:

a charged particle beam source;

a shaping system for shaping a charged particle beam emerging from said charged particle beam source to have an arcuate cross-section;

a projection optical system including a projection lens including a pair of magnetic lenses, said projection optical system being located between said shaping system and said substrate stage;

a driver for supplying excitation currents to said pair of magnetic lenses to drive said projection lens; and

a controller for controlling a ratio of the currents to be supplied from said driver to said pair of magnetic lenses to move a position of a principal plane of said projection lens.

2. The apparatus according to claim 1, wherein said controller controls the ratio of the currents to be supplied from said driver to said pair of magnetic lenses so as to correct an image distortion of said projection optical system.

3. The apparatus according to claim 2, wherein

said projection optical system includes a second projection lens including a pair of magnetic lenses to which excitation currents are supplied from said driver, and

said controller controls a ratio of the currents to be supplied from said driver to said pair of magnetic lenses of said second projection lens to move the position of the principal plane of said second projection lens so as not to change an image position and magnification of said projection optical system when correcting an image distortion of said projection optical system by controlling said first projection lens.

4. The apparatus according to claim 1, wherein

said projection apparatus further comprises acquisition means for acquiring image information indicating a feature of an image projected onto said substrate stage by measurement, and

said controller controls the ratio of the currents to be supplied to said pair magnetic lenses so as to correct an image distortion of said projection optical system on the basis of the image information.

5. The apparatus according to claim 4, wherein the image information contains information indicating a radius of an image formed on said substrate stage with the arcuate cross-sectional charged particle beam emerging from said shaping system.

6. The apparatus according to claim 5, wherein said controller controls the ratio of the currents to be supplied to said pair of magnetic lenses, so that the measured radius coincides with a theoretical radius obtained when said projection optical system has no aberration.

7. The apparatus according to claim 4, wherein the image information is information indicating an image height of an image formed on said substrate stage with the arcuate cross-sectional charged particle beam that has passed through said shaping system.

8. The apparatus according to claim 7, wherein said controller controls the ratio of the currents to be supplied to said pair of magnetic lenses, so that the actually measured image height coincides with a theoretical image height obtained when said projection optical system has no aberration.

9. The apparatus according to claim 4, wherein

said mask stage is arranged between said shaping system and said projection optical system,

said acquisition means comprises

an image distortion measurement mask having a transmitting system that passes therethrough a predetermined portion of the arcuate cross-sectional charged particle beam emerging from said shaping system, said mask being held by said mask stage during measurement, and

a measurement unit for measuring coordinates of a position where the charged particle beam that has passed through said transmitting system becomes incident on said sample stage, and

image information indicating a feature of an image projected onto said substrate stage is calculated on the basis of the measured coordinates.

10. The apparatus according to claim 9, wherein

said image distortion measurement mask has a plurality of transmitting systems arranged arcuatedly, and

said measurement unit measures coordinates of respective positions where charged particle beams that have passed through said transmitting systems become incident on said substrate stage.

11. The apparatus according to claim 10, wherein

said acquisition means calculates a ~~ra~~dius of an image projected onto said substrate stage on the basis of a plurality of measured coordinates, and

said controller controls the ratio of the currents to be supplied from said driver to said pair of magnetic lenses, so that a radius obtained by measurement coincides with a theoretical radius obtained when said projection optical system has no aberration.

12. The apparatus according to claim 9, wherein

said acquisition means further comprises a substrate having a mark, said substrate being placed on said substrate stage during measurement, and

said measurement unit detects backscatter electrons from said substrate, thereby measuring coordinates of a position where the charged particle beam that has passed through said transmitting system becomes incident on said substrate stage.

13. The apparatus according to claim 12, wherein measurement of the coordinates of the incident position is performed while moving said substrate stage such that the mark moves across the position where the charged particle beam that has passed through said transmitting system becomes incident on said substrate stage.

14. The apparatus according to claim 13, wherein said mark is a crisscross mark made of a heavy metal.

15. A control method for a projection apparatus having a mask stage for holding a mask, a substrate stage for placing thereon a sample on which a pattern formed on said mask is to be projected, a charged particle beam source, a shaping system for shaping a charged particle beam emerging from said charged particle beam source to have an arcuate cross-section, a projection optical system including a projection lens including a pair of magnetic lenses, said projection optical system being located between said shaping system and said substrate stage, and a driver for supplying excitation

currents to said pair of magnetic lenses to drive said projection lens, said method comprising:

the acquisition step of acquiring correction information necessary for correcting aberrations of said projection optical system; and

the control step of controlling a ratio of the currents to be supplied from said driver to said pair of magnetic lenses to move a position of a principal plane of said projection lens.

16. The method according to claim 15, wherein the control step comprises correcting an image distortion of said projection optical system on the basis of the correction information.

17. The method according to claim 16, wherein

said projection optical system includes a second projection lens including a pair of magnetic lenses to which excitation currents are supplied from said driver, and

the control step comprises controlling a ratio of the currents to be supplied from said driver to said pair of magnetic lenses of said second projection lens to move a position of a principal plane of said second projection lens so as not to change a field position and magnification of said projection optical system when correcting an image distortion of said projection optical system by controlling said first projection lens.

18. The method according to claim 15, wherein

the acquisition step includes the measurement step of acquiring by measurement image information indicating a feature of an image projected onto said substrate stage as the correction information, and

the control step comprises correcting an image distortion of said projection optical system on the basis of the image information.

19. The method according to claim 18, wherein the image information contains information indicating a radius of an image formed on said substrate stage with the arcuate cross-sectional charged particle beam emerging from said shaping system.

20. The method according to claim 19, wherein the control step comprises controlling the ratio of the currents to be supplied to said pair of magnetic lenses, so that the measured radius coincides with a theoretical radius obtained when said projection optical system has no aberration.

21. The method according to claim 18, wherein the image information is information indicating an image height of an image formed on said substrate stage with the arcuate cross-sectional charged particle beam that has passed through said shaping system.

22. The method according to claim 21, wherein the control step comprises controlling the ratio of the currents to be supplied to said pair of magnetic lenses, so that the actually measured image height coincides with a theoretical image

height obtained when said projection optical system has no aberration.

23. The method according to claim 15, wherein

said mask stage is arranged between said shaping system and said projection optical system,

said acquisition step comprises

the preparation step of causing said mask stage to hold an image distortion measurement mask having a transmitting system that passes therethrough a predetermined portion of the arcuate cross-sectional charged particle beam emerging from said shaping system,

the measurement step of measuring coordinates of a position where the charged particle beam that has passed through said transmitting system becomes incident on said substrate stage, and

the calculation step of calculating, as correction information necessary for correcting an image distortion of said projection optical system, image information indicating a feature of an image projected onto said substrate stage on the basis of the measured coordinates, and

the control step comprises controlling the ratio of the currents to be supplied from said driver to said pair of magnetic lenses to move a position of a principal plane of said projection lens so as to correct an image distortion of said projection optical system on the basis of the correction information.

24. The method according to claim 23, wherein

said image distortion measurement mask has a plurality of transmitting systems arranged arcuately, and

the measurement step comprises measuring coordinates of respective positions where charged particle beams that have passed through said transmitting systems become incident on said substrate stage.

25. The method according to claim 24, wherein

the calculation step in the acquisition step comprises calculating a radius of an image projected onto said sample stage on the basis of a plurality of measured coordinates, and

the control step comprises controlling the ratio of the currents to be supplied from said driver to said pair of magnetic lenses, so that a radius obtained by measurement coincides with a theoretical radius obtained when said projection optical system has no aberration.

26. The method according to claim 23, wherein

the acquisition step further comprises the step of placing a substrate having a mark on said substrate stage before measurement, and

the measurement step in the acquisition step comprises detecting backscatter electrons from said substrate, thereby measuring coordinates of a position where the charged particle beam that has passed through said transmitting system becomes incident on said substrate stage.

27. The method according to claim 26, wherein the measurement step comprises measuring the coordinates of the incident position while moving said substrate stage such that the mark moves across the position where the charged particle beam that has passed through said transmitting system becomes incident on said sample stage.

28. The method according to claim 27, wherein said mark is a crisscross mark made of a heavy metal.

29. A method of manufacturing a device, comprising the steps of:

fixing a mask on said mask stage of said projection apparatus according to claim 1;

placing a sample on ~~said~~ sample stage of said projection apparatus; and

transferring a pattern formed on said mask onto said sample.